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Fishery and biology of *Priacanthus hamrur* (Forsskal) along the Indian coast

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ABSTRACT

Fishery trend of bull's eye (Family:Priacanthidae) along the Indian coast and some biological aspects of *Priacanthus hamrur* (Forsskal) off Cochin are presented in this paper. Coastwise, the resource is landed more in the west coast from a depth range of 20-150m than the east coast, from a depth range of 10-80m. Seasonally, priacanthids were abundant during October-March along the north west coast and during December - March and August-October along the south west coast. *P. hamrur* prefers pelagic crustaceans followed by fishes and smaller molluscs as food.lt appears to breed mainly during April-July, shedding two batches of ova. Gonado -somatic indices showed peak values during June in both sexes. Size at maturity of males and females were 181- 190mm and 191-200mm respectively. Chi -square test indicated females to dominate the population. Fecundity ranged between 1,55,800 and 7,22,313. The *V* value in the length -weight relationship of the two sexes was statistically significant at *5%* level.

Introduction

Commercial trawling in the deep has started exploiting non conventional fishes such as *Priacanthus spp.,Ariomma indica* and *Chlorophthalmus* spp. Unlike other non conventional fishes, *Priacanthus* spp. (Family Priacanthidae), commonly called bull's eye or big eye has started emerging as an important fishery resource in the trawl landings along both the west and east coasts of India. Nevertheless, information regarding their abundance and biology was based on their representation in exploratory surveys (Joseph 1986; Joseph and John, 1986;Sivaprakasam, 1986; Gopalakrishnan *et al.*, 1988; John and Sudarsan, 1988; Sudarsan *et al.*, 1987,1988; Vijayakumaran and Naik, 1988;Bandee*a£, 1989 James and Pillai, 1989; Sivakami, 1989,1998; Philip, 1994, 1998, Philip and Mathew, 1996 a,b; Varghese 1995,1998 and Premalatha, 1997), except for the studies made by Rao(1984) andZachariaefaZ. (1991). The present paper elucidate the fishery of priacanthids along the Indian coast based on commercial landings with some information on the biology *of Priacanthus hamrur* (Forsskal) off Cochin.

Materials and methods

Data on bull's eye landed in commercial trawlers (OAL:14 m & below) from April 1996 to March 1999 off Veraval, Mangrol, Bombay, Calicut (Puthiappa and Beypore) and Cochin along the west coast, Madras and Vishakhapatnam along the east coast were considered for this study. Monthly average during 1996-'99 was reckoned for presenting the data.

For biological studies, weekly samples of *Priacanthus hamrur* collected were measured to the nearest mm and g after which the maturity conditions were observed. Food preference was studied by applying the Index of Preponderance method (Natarajan and Jhingran, 1961). Maturity stages were determined following the scale adopted by the International Council for Exploration of Sea (Lovern and Wood, 1937) with suitable modifications. Size at maturity was determined by grouping the gonads in different maturity stages into 10mm size groups. Spawning season was ascertained by recording the percentage occurrence of gonads in various maturity stages every month. Specimens above size at maturity alone were considered for this purpose. The Gonado-Somatic Index was determined applying the formula:

$$\frac{\text{Weight of gonad} \times 100}{\text{Weight of body}}$$

Sex ratio was tested by applying 'Chi square" method. Fecundity was worked out by raising the number of ova in a sub sample of the ovary to its weight. The length-weight relationship was derived employing the least square method based on the formula Log W = a+b Log L where W = Weight of the fish in g., L = Length in mm, a and b are constants.

Results

Fishery

The priacanthids landing was high at Beypore (817.683t., 25.86Kg/E), Puthiappa (732.693t.,20.57Kg/E), Veraval (522.242t., 5.77Kg/E)and at Cochin(290.784t., 10.48Kg/E)during 1996-'97 which declined during '97-'98 and '98-'99 in all these centres. Along Bombay, the catch increased from 237.245t.(5.29Kg/E) during '96-'97 to 742.927t.(26.28Kg/E) in '98-'99. The centres along the east coast (Madras and Vishakhapatnam), though with lesser catches, indicated an increasing trend in landings during the study period.The depth of operation of trawlers was 20-150m off west coast and 10-80m along the east coast. Being an emerging resource, the percentage contribution of bull's eye in the total marine landings was low, ranging between 0.13% to 2.27%at various centres (Table 1). *Priacanthus hamrur* was the only species represented in the commercial landings during the period of study.

Bull's eye landings along Veraval, Mangrol and Mumbai brought higher catch rates during October-March. At Calicut, the peak landing was during December-March with lesser abundance during April - August, while at Cochin, the peak landing was during August-October (Table 2).

Along the east coast, bull's eye landings off Madras indicated a distinct peak during July-September , while at Vishakhapatnam, higher catch rates were obtained during March-April and July.

Biology

Food prference: A total of 328 specimens of*P. hamrur* (165-327mm) collected from trawl landings off Cochin during January '97-February ^8 were used for food analysis (Table 3). *P. hamrur* is mainly a carnivore, feeding on pelagic crustaceans followed by fishes and smaller molluscs. Among crustaceans, euphausids, was the

most preferred food item followed by crabs (megalopa larvae of brachyurian crab, *Porcellanid* spp., *Portunus* spp.), penaeid shrimps and stomatopods (Squilla and alima larvae). Fishes were represented by a variety of species such as *Stolephorus* spp., silverbellies, *Saurida* spp., flatfishes and flat heads was the next preferred group. Molluscan food items were dominated by juveniles of squids, cuttlefish, *Octopus* spp. and also smaller gastropod shells. In most cases, food was in a digested condition, which may be due to the delay in landing the catch.

Breeding biology: The gonads are bilobed, united in the middle and opening out through a common duct behind the anus. The ovaries could be identified in 7 successive maturity stages namely:- stage I (Immature): small, butterfly shaped, transparent, light pinkish, ova transparent

TABLE 2. *Monthly average catch rate (KglE) of bull's eye landed at selected centres along the Indian coast during 1996-'99*

	Veraval	Mangrol	Mumbai	Calicut #	Cochin	Vishakhapatnam	Madras*
January	7.95	2.61	29.06	3927	6.387	3.89	0.0075
February	3.74	3.72	3124	63.87	6553	3.083	0.053
March	653	a74	2559	29.61	2.593	851	0.007
April	ai4	209	925	1556	2566	6.833	0.0009
May	1.93	293	1859	1827	8.98	2.91	0
June	0	0	0	1354	8.317	1.53	0.07
July	0	0	0.66	0	8553	10.966	0.42
August	0	0	227	24.75	12.49	4.626	0.15
September	255	0.84	0.46	a66	152	4.437	0.135
October	3.41	237	5.46	03	13.38	554	0.04
November	5.02	054	15.18	12.63	8507	3.74	0.003
December	0	6.39	a7i	27.76	95	5517	0

= CPUE for Beypore and Puthiappa are given together
* = CPUEinKg/hr.

with ova diameter ranging upto 150(x ; stage II (maturing): slightly enlarged, light yellowish, transparent with ova diameter ranging upto 250^; stage III (maturing): ovary bilobed, tapering posteriorly but fused in the centre, light orangish, with ova diameter ranging upto 400u, stages IV and V(mature): almost identical, ovary wing shaped, enlarged, opaque and thick, orangish, with ova diameter ranging upto 500u, stage Vl(ripe): ovary much enlarged, deep orangish, flabby with ova diameter ranging upto 650(1, spent ovaries (identifiable in 3 substages): stage Vila (partially spent): ovary dull reddish, shrunken, dark yellowish with part of the ripe ova upto 600^1 retained., stage Vllb (partially spent) : ovary reduced in size, blood shot with ova diameter ranging upto 400ji, stage VIIc (fully spent): ovary dull reddish much reduced in size, bag like with only immature ova present.

In testis, the 7 stages identified were:stage I (immature): thin triangular, with the anterior end tapering; stage Il(maturing) : testis opaque, roughly triangular and pointed anteriorly; stage Ill(maturing): testis slightly enlarged, cream coloured; stage IV (mature): testis much enlarged, opaque, thick, roughly triangular; stage V (mature): testis whitish, triangular, flabby; stage VI (running): identical to stage V but much enlarged in size; stage Vll(spent): shrunken, reduced in size, dull creamy in colour.

The ova diameter frequency polygons in ovaries of successive maturity stages are given in Fig. I. In stage I, there is only one batch of immature ova with a mode at 0-50 u, while in stage II, the ova diameter had increased with the mode shifted to 101-150u. As development progressed in stage Ill.this mode shifted to 151-200^. In stage IV, the mode at 151-200 \i. progressed to 301-350^ with a secondary mode at 151-200jx. In stage V, although the major mode shifted to 351-400^, the secondary mode did not show any further development. In stage VI, the 351-400|i mode was well differentiated with the mode at 451-500^ and the secondary mode at 151 -200u. In

TABLE 3. *Index of preponderance of food items in* Pricanthus hamrur *off Cochin*

Food items	Occurrence/Volume(ml)				
	Oi(%)	Vi (%)	ViOi	ViOixlOO SViOi	Rank
Fishes					
Flat heads	112	133	0.05	0.17	
Flatfishes	1.69	208	351	059	
Saurida spp.	0.85	348	296	054	
Stolephorus spp.	254	9.78	2434	2.04	6
Leiognathus spp.	1.97	3.67	432		
Decapterus sp.	058	0.49	0.14	0.01	
Nemipterus sp.	058	0.73	*02*	0.02	
Goat fishes	058	133	051	0.04	
Tbadfish	*028*	1.47	0.41	0.03	
Perch juvenile	*028*	0.67	0.18	0.02	
Bregmaceros sp.	*028*	*024*	0.06		
Fish juveniles	1.41	252	357	057	
Fish digested	R45	1232	104.1	855	3
Crusteaceans					
Euphausids	1857	2221	419.1	34.41	2
Penaeids	&48	5.12	33.18	2.72	5
Crabs	10.42	ao?	84.09	69	4
Stomatopods	L13	0.43	0.49	0.04	
Lucifer	056	0.12	0.07		
Other shrimps	*028*	0.12	0.03		
Crustaceans	535	441	23.6	L94	7
Molluscs					
Squids	109	aos	9.42	0.77	8
Gastropods	056	0.43	054	0.02	
Sand particles	*028*	0.02			
Digested matter	3324	15.08	50156	41.15	1
1 ni	100	100	1218.03	100	

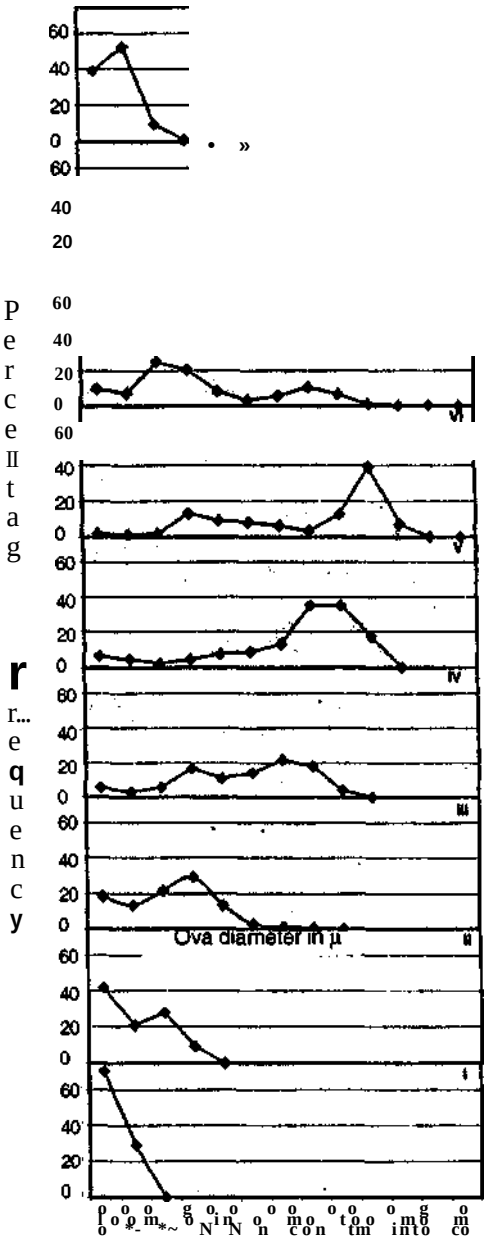
the partially spent ovary in stage Vila, the major mode was partially released while the secondary mode had developed further but with the mode retained at 151 -200 *[i.* In stage Vllb.the major mode was fully released with the minor mode shifted to 301-350 \i. In stage VIIc, only immature ova were discernible with mode at 51-100ji.

An evaluation of the progression of ova towards maturity in *P. hamrur* indicated that there were 2 batches of ova with modes at 451-500^1 and 151-2000. The mature ova with the mode at 451-500u formed a distinct group followed by a developing batch with the mode at 151-200(0„ which progressed to 301-350 u after the first batch was released and since the fully spent ovary (VIIc) stage had only immature ova, it may be concluded that *P.hamrur* sheds two batches of ova during the extended spawning season.

The gonads were grouped into immature, maturing (stages I&II), mature (stages III & IV), ripe(stages V&VI) and spent(stages Vlla-c). The average monthly percentage for the years 1996-'99 off Cochin and 1997-2000 off Mumbai are presented in Fig. 2a,b and c respectively.

Ovaries in stages I&ll (including spent recovering stages) were represented more during August-January, while those in stages III & IV were less frequently encountered with their peak during November and from January to March. Ripe ovaries in stages V & VI were represented mainly during April - July with less frequency during November-December. Ripe ovaries formed upto 82.81% in April. Ovaries in spent condition (upto 20%) were encountered more from May to September and in November.

The males of P. *hamrur* also had the testis in stages I &II mainly during August January. Stages III & IV were noticed more during March - July period, while those in stages V & VI were found dominant during



Ova diameter in u

Fig 1. Ova diameter frequency polygons of *P. hamrur* off Cochin.

April - July and they formed upto 73.92% in May.

Since the occurrence of ripe gonads

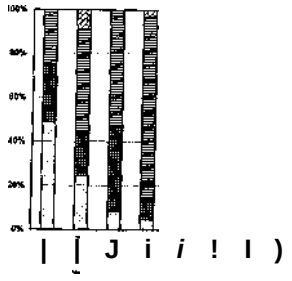


Fig.2a. Percentage occurence of different stages *1* of ovaries in *P.hamrur* off Cochin.

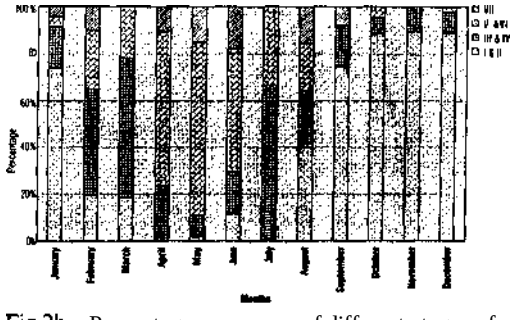


Fig.2b. Percentage occurence of different stages of testes in *P.hamrur* off Cochin.

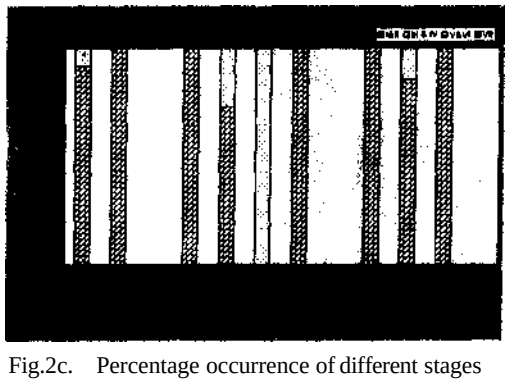


Fig.2c. Percentage occurrence of different stages ovaries in P.hamrur off Mumbai.

were more during April to July with higher incidence of the spent ones from May to September, it may be concluded that *P. hamrur* off Cochin has an extended spawning season during April - July

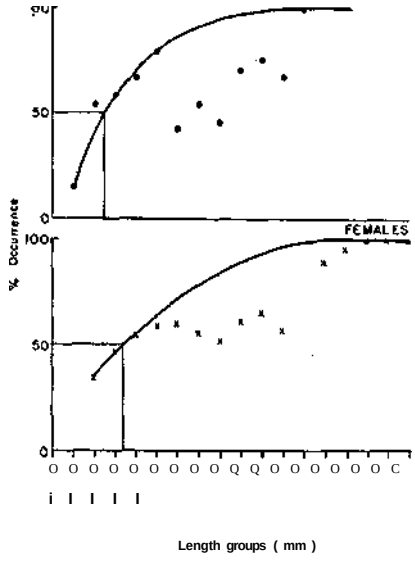


Fig.3. Size at maturity of *P.hamrur* off Cochin.

shedding two batches of ova. However, since ripe and spent gonads were noticed during November - December also, it is possible that the species breed during this period also.

It may be seen that off Mumbai, *P.hamrur* observed were mainly in immature and maturing stages with lesser frequency of mature gonads and with no ripe or spent ovaries recorded even in larger specimens. The immature and maturing ovaries formed 72.73% during May and 100% during February, April, July, September and November while mature

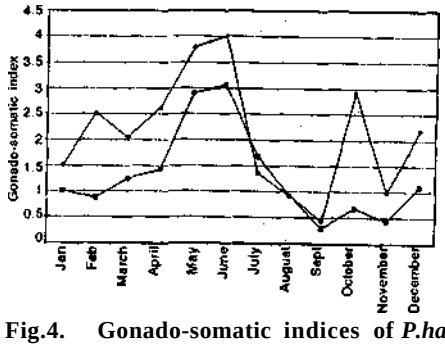


Fig.4. Gonado-somatic indices of *P.hamrur* off Cochin.

ovaries formed 9.09% during January and 100% during June.

The diameter measurements of 1500 ova taken from a ripe ovary of P. *hamrur* revealed that the ovary contained one batch of ripe ova within the diameter range of 351 -500 n which formed about 53% of the total ova measured. Since this batch of ova is very close to the maximum ova diameter of 650 u collected during the first week of May, it is possible that this batch will be spawned during May-June. 29% of the total ova measured were yolk laden within the diameter range of 151-300 (X, a secondary mode. Since this batch is yolk laden, having reached halfthe size that of the first mode of ova, it is possible that this secondary batch will also be shed in due course indicating that *P. hamrur* off Cochin sheds 2 batches of ova during the breeding season.

Specimens of *P. hamrur* collected during the study period were grouped into 10 mm size groups and the percentage of ovaries above stage HI were considered for this study. It may be seen that mature gonads formed 47.37 % in size group 181 - 190 mm and 50 % of the sample had mature ovaries in size group 191 -200mm, which may be considered as the size at maturity of females (Fig.3). In males 53.5% of size group 171-180mm and 58% in size group 181-190mm were in mature condition. The size group 171- 180mm in which 50% had the testis in mature condition may be considered as the size at maturity.

Gonado-somatic index : The GSI of both males and females indicated an extended spawning season in the species with the peak in June during April to July and with a minor peak during October (Fig.4). The maximum values recorded were 3.07 in males and 4.01 in females both during June.

Sex ratio : An evaluation of the sex ratio showed that females were dominant in the population except during April, July and December(Table 4).Chi-square values indicated that the difference in the ratio was significant at 5% level.

TABLE 4. *Chi-square test for sex ratio* P.hamrur *)ff Cochin during 1996-'99 (pooled)*

Months	Males	Females	Tbtal	X^2
January	21	36	57	3.94*
February	88	162	250	21.9*
March	33	69	102	12.71*
April	34	51	85	3.40
May	50	80	130	6.92*
June	19	61	80	22.05*
July	4	6	10	0.40
August	49	74	121	5.08*
September	43	82	125	12.17*
October	46	82	128	13.44*
November	18	53	71	17.31*
December	55	57	112	0.04
Pooled	460	813	1273	97.89*

* Significant at 5% level.

Fecundity: Atotal of 18 ripe specimens of P. *hamrur* within the length range of 23 to 327mm and 160 to 390g were used for estimating the fecundity.

Fecundity of *P. hamrur* ranged between 1,55,800 to 7,22,313 (average: 3,80,071). The number of ova per gram weight of mature ovary ranged between 19,440 to 45,900 (average: 30,659), while the number of ova per gram body weight (fecundity factor) varied between 623 to 2867(average: 1631).

Length-weight relationship: Atotal of 255 female specimens within a total length range of 175-317 mm and weight range of 68-380g and a total of 116 male specimens within a total length range of 165-293 mm and weight range of 62-290g were used for analysing the length- weight relationship.The results are given below:

Males : - 4.034868+2.626081 log L (r=0.981071)

Females: - 4.307500+2.743857 log L (r=0.984473)

The data subjected to analysis of covariance (Snedecor, 1961) indicated that b values differ significantly in males and females (F-ratio 4.14 on 1.367 d.f.).

Discussion

Exploratory surveys conducted along the Indian EEZ have revealed higher concentration of bull's eye along the west coast than the east coast (James and Pillai, 1989; Sivakami, 1989; Sudarsan, 1993). Joseph (1986) studying the potential fishery resources from the Indian EEZ had also observed a maximum catch rate of 39 kg/hr between 15 and 18°N along the west coast and the least catch rate of 6 kg/hr between 10 and 15°N along the east coast. However, John and Sudarsan (1988) have reported highest stocking density of 4 to 6t/km^2 off Tamil Nadu in the latitude of 12-14°N between 100 - 200m depth. Sudarsan *et al.* (1988) have also reported a catch of 3.2 -6.3t/Km between 12-14°N off the east coast and 1.0-3.7t between 14-16°N off the west coast in 100-200m depth. In the present study, the catch rate of bull's eye resource along the east coast from a depth range of 10-80m, ranged only upto 8.96 Kg/E when compared to the higher catch rate of 26.28Kg/E from a depth range of 20-150m along the west coast. The reasons for such variation in the landings between coasts and zones may be attributed to the difference in the width of the shelf area along the coasts, the positive impact of monsoon and upwelling phenomena, the richer standing crop of zooplankton in the Arabian Sea and the greater availability of the relished food items such as the euphausids (Mathew and Natarajan. 1989).

The distribution of priacanthids more in 40-100m depth range along the south west coast and 100-200m depth range along the north west coast has been reported by Banded *al.* (1989), Sudarsan *etal.* (1988), Sivakami(1989,98) and Premaletha(1997). John and Sudarsan (1988) found the 100-200m depth zone at 14-16°N along the west coast to be more productive for bull's eye and concluded that the resource inhabits the continental shelf and slope with large concentration in the intermediate zone. The present study based on commercial landings brought from a depth of 20-150m along the west coast though indicated regional variations in the catch trend over the years, could not delineate any bathymetric variation in their distribution. Nevertheless, the fluctuation in the catches in time and space is indicative of the probable movement of the species between shallow and deeper waters with abundance in the intermediate depth upto 150m along the west coast.

Biradar(1988), observed that the species was caught more along the northwest coast during July- September. Vijayakumaran and Philip (1990) found the lowest catch rates of *Priacanthus* spp. in

July- August period brought along the south Maharashtra to north Kerala coast where higher catch rates recorded from September to November. Vijayakumaran and Naik (1988) have concluded that *P.hamrur* perform a shallow water migration during premonsoon months towards south, to deeper waters. The present study revealed that the species spends their immature and maturing stages along the north west coast during premonsoon months, moving towards the south to breed during the April - July period. Their lesser abundance along the south west coast at a depth range of 20-150m during the breeding season (April-July) indicated that they bred away from the fishing grounds as has been reported by Vijayakumaran and Philip(1990) and that the resource was more abundant in the 200-500m depth zone during May - July along the north Kerala-Karnataka coast.

Food habit of P. *hamrur* indicated that the species was a carnivore with pelagic crustaceans as the most favoured food item followed by fishes and smaller molluscs. Similar observations were made in *P. hamrur* (Philip, 1994,1998,Premaletha, 1997), in P. *tayenus* (Rao, 1967) and in P. *macracanthus* (Rao, 1984). However, a closer examination of the dominant food items clearly indicated more of a deep water habitat of the species. Thus, according to Philip (1994,1998), the food items were represented by mesopelagic fishes *(Bregmaceros* spp., *Acropoma* spp. and deep sea prawns *Solenocera* spp.), while according to Bande *et al.* (1989), *Priacanthus* spp. fed voraciously on pelagic shrimps *(Leptochela* spp.) of the DSL ascending to epipelagic realm during night. Peter (1982) and Mc Farland(1991) state that priacanthids are reef dwelling nocturnal planktivorous fishes which locate their food items through their sense of vision. Hobson (1991) reports that *P. cruentatus* from the Hawaiian reef migrate seaward to feed upon pelagic organisms such as cephalopods and crab megalopa larvae.

Being a non-conventional fishery resource, the information available on the breeding biology of *Priacanthus* spp. is scanty. Rao (1984), studying the biology of *P. macracanthus* off Waltair coast observed the species to breed during November - February. Philip (1994) noticed the same species to breed during October - March period off Vishakhapatnam. Premaletha (1997) observed ripe specimens of *P. hamrur* during March-April along the south west coast.In the present study, 82.81% of ripe ovaries encountered during April-July and 20% spent ovaries obtained during May-September clearly indicate an extended spawning season of the species during April-July. However, since ripe/ spent gonads were noticed during November-December also, it may be concluded that some individuals breed during these months also.

One batch of well differentiated ova followed by a secondary batch of developing ova was discernible in the ripe ovary of *P.hamrur.* Since the secondary batch contains rather large yolked ova which have reached more than half the diameter of the first batch of ripe ova and since they form about 29% of the total ova size frequency, it is possible that this secondary batch also will be shed during the extended spawning season during April-July period. Nevertheless, Philip(1994) in *P. hamrur* and Rao (1984) in *P. macracanthus* have reported along the north east coast, a single batch of ripe ova sharply separated from the rest of the stock. And such regional variations in spawning frequencies in reef fishes likes priacanthids may be correlated with gross seasonality of environmental variables such as water current, wind patterns, seasonal cycles of primary productivity, temperature and day length which may affect the food supply, growth

and dispersal of larvae (Robertson, 1991).

Analysis of covariance to test the significance of regression co-efficient in the length weight relationship of male and female *P. hamrur* showed that b values differ at 5 % level of significance.While Philip(1994), Philip and Mathew (1996) have observed the slope and elevations significantly different for males and females of P. *hamrur,* Varghese (1998) concluded that the 'b' value of *P. hamrur* does not follow the Cube Law. On the other hand, Joung and Chen, (1992) in Taiwan waters and Wetchagarun (1971) in the gulf of Thailand noticed little difference in the 'b' value of the two sexes of P. *macracanthus.* Likewise, Chanta Wong (1984) obtained a combined b value of 2.5 for P. *tayenus* from Andaman Sea. Such differences noticed in the growth of same species by different authors may be due to variations in the representations of different year classes used for arriving at the length- weight relationship.

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References

Bande, V.N., N.G.Menon and KBalachandran 1989. Studies on the distribution and abundance of Bull's eye *(Priacanthus* spp.) in the EEZ of India, 233-239 *Proc. First Workshop Scient. Resul. FORV Sagar Sampada.* Edited by K.J.Mathew (CMFRI.Cochin). 233-239.

Biradar, R.S. 1988. Estimates of stock density, biomass and maximum sustainable yield of *Priacanthus hamrur* (Forsskal) off the north west coast of India. *Fish. Surv. India, Spl. Pub.* 2: 55-65.

*ChantaWong , T. 1984. Trawl fisheries and the present status of demersal resources in the Andaman sea. Paper presented to the *Marine Fisheries Seminar,* BANGKOK, 4-7 September 1984 (Mimeo).

Gopalakrishnan, K.,C. Benjamin, D.Varghese, M.AH and Paul Pandian 1988. Deep sea resources of Indian EEZ (beyond 150m depth). *Nat.Workshop Fish Res.Data Fishing Industry.* October 14-15 Vishakhapatnam.

Hobson E.S.1991. Trophic relationships of fishes specialised to feed on zooplankters above coral reefs. In: *The Ecology of Fishes on coral* reefs, p.90. Peter F.Sale (Ed.) Academic Press Inc., San Diego, California 92101.

James. P.S.B.R. and V.N.Pillai 1989. Fishable concentrations of fishes and crustaceans in the offshore and deepsea areas of the Indian EEZ based on observation made onboard FORV Sagar Sampada, *Proc. First Workshop Scient. Resul. FORV Sagar Sampada.* Edited by K.J.Mathew (CMFRI.Cochin). 201-213.

John, M.E.and D.Sudarsan 1988. Assessment of the stock of Big eye snappers (Fam.Priacanthidae) in Indian seas with a note on their pattern of abundance. *Symp. Tropical Marine Living Res.,* 12-16. January 1988, Cochin. Abst.No.232.

Joseph, KM. 1986. Some observations on potential fishery resources from the Indian EEZ. *Bull. Fish.Surv.India.* 14:1-20.

Joseph, KM. and M.E.John 1986. Potential Marine Fishery Resources in Indian EEZ. *Seminar on Potential marine Resources, CMFRI, Spl.Publ.,30:* 18-43.

*Joung, S.J. and C.T.Chen 1992. Age and growth of the big eye *Priacanthus macracanthus* from the surrounding water of Guei-Shen Island .Taiwan, *Nippon Suisan Gakkaishi.* 58(3):481-488.

Mathew, K.J. and S.Natarajan 1989. Investigations on the DSL of the Indian EEZ with special reference to euphausids as

a component. In: *Proc.First Wokshop Scient. Resul. FORV Sagar Sampada,* edited by KJ.Mathew (CMFRI.,Cochin) 375-385.

*Mc Farland, W.N. 1991 .The visual world of coral reef fishes.In: *The Ecology of Fishes on coral reefs.* Peter F.Sale (Ed.). P.27. Academic Press,San Diego, California.

Natarajan, A.V. and V.G.Jhingran 1961. Index of Preponderance- method of grading the food elements in the stomach analysis of fishes. *Indian J.Fish.,* 8:54-59.

Peter, M.B. 1982. *Fishes. An Introduction to Ichthyology.* 129 pp. Printice Hall. Inc. Englewood. Cleffs, New Jersy.

Philip, K.P. 1994. *Studies on the biology and fishery of the fishes of the family Priacanthidae (Pisces: Perciformes) of Indian waters.* Ph. D. Thesis, Cochin University of Science and Technology, Cochin.

Philip, K.P. 1998. Food and feeding habits of *Priacanthus hamruriForskal)* from the upper east coast. *Fish. Surv. India. Bull.,* 26: 12-25.

Philip, K.P. and K. Mathew 1996a. Growth, mortality and exploitation *of P. hamrur* from the north east coast of India. *J.mar. biolAss. India* , 38 (1&2): 106-113.

Philip.K.P. and K.Mathew 1996b. Length weight relationship and relative condition factor in *Priacanthus hamrur. Fish Technol.,33* (2): 79-83.

Premalatha, P. 1997. On the fishery and biology of *Priacanthus hamrur* Forsskal along the south west coast of India. *Indian J. fish.,* 44(3); 265-270.

Rao,K.S. 1967. Food and feeding habits of fishes from trawl catches in the Bay Bengal with observations on diurnal variation in the nature of feed. *Indian J.Fish.,11:* 277-314.

Rao.T.A. 1984. On some aspects of biology of *Priacanthus macracanthus* (Cuvier). *Indian J.Fish.,* 31: 380-382.

Robertson, D.R. 1991. The role of adult biology in the timing of spawning of tropical reef fishes. In: *The ecology of fishes of coral reefs,* 371pp. Peter F.Sale, (Ed.) Academic Press.Inc.San Diego, California, 92101.

Sivakami, S. 1989. Observations on the demersal fishery resources of the coastal and deep sea areas of the EEZ, of India. 215-233. *Proc. First Workshop Scient. Resul.FORVSagar Sampada* (CMFRI., Cochin)

Sivakami.S., E.VLvekanandan, P.Nammalwar, M.Feroz Khan, P.U.Zacharia, G.Mohan Raj, Grace Mathew and P.Jayasankar 1998. The non conventional finfish resources of the Indian EEZ.In: *Tech.Adv. in Fish.* 243-255.M.S Hameed and B.M.Kurup (Eds.). Publ.No.l School of Industrial Fish., Cochin Univ. Sci. Technol., Cochin.

Sivaprakasam, T.E. 1986. What is in store in deep sea? Results of exploration into the demersal fishery resources of the Indian EEZ. *Occ. Pap. Fish. Surv. India,* 3:23pp.

Snedecor, G.W.1961. *Statistical methods.* Allied Pacific Private Limited, Bombay.

Sudarsan,D., M.E.John, and A. Joseph 1987.An assessment of demersal stocks in the south west coast of India with particlular reference to exploitable resources in the outer continental shelf and slope. *Bull. Cent. Mar. Fish.Res.Inst.,* 44(1): 266-272.

Sudarsan,D.,TE. Sivaprakasam, V.S.Somvanshi, M.E. John, KN.V.Nair and Antony Joseph 1988.An appraisal of the marine fishery resources of the Indian EEZ. *Bull.Fish.Surv.India,* 18:85pp.

Sudarsan, D. 1993. Marine Fishery Resources in the EEZ of India. *Proc.Nat. Workshop Low Energy Fishing,* 8-9 August 1991. 3-11.

Varghese, S.1995. Biological aspects and stock assessment of the deep sea fish *Priacanthus hamrur* (Forsskal) of the *north west coast of India.* M. Sc. Thesis, Mumbai University.

Varghese, S. 1998. Length weight relationship *of Priacanthus hamrur* along the north western Indian EEZ. *Bull. Fish. Surv. India,* 26: 51-54.

Vijayakumaran, K and S.K Naik 1988 A study of the stock of *Priacanthus hamrur* (Forsskal) during March and September between lat. 11 - 16°N along the west coast of India. In: *Studies on Fish Stock Assessment in Indian waters. Fish.Surv. India Spl.Publ.,* 2 : 106-119.

Vjiayakumaran, K. and K.P.Philip 1990.Demersal fishery resources off North Kerala -Karnataka -Konkan coast *J.mar. bioLAss. India,* 32 (1&2): 177-187.

*Wetchagarun, K. 1971. Some aspects of the biology of spot-finned big eye *(Priacanthus tayenus)* in the inner part of Gulf of Thailand (1969-'70). Second *Symp. Mar. Fish. Bangkok,* Marine Fisheries Laboratory, 19-20 April, 1971, 240 pp

Zacharia, P.U., K.Sunil Kumar Mohammed, P.P. Pillai and C.Purandhara 1991. Bull's eye-An emerging trawl fishery resource along Dakshina Kannada coast. *Mar. Fish. Infor. Serv. T& E. Ser.,* 114:29-30.

Not referred to in original.